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TECHNOLOGY AND HANDICAPPED PEOPLE

SEPTEMBER 1982

BACKGROUND PAPER #1: MANDATORY PASSIVE RESTRAINT SYSTEMS IN AUTOMOBILES: ISSUES AND EVIDENCE

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OTA Background Papers are documents containing information that supplements formal OTA assessments or is an outcome of internal exploratory planning and evaluation. The material is usually not of immediate policy interest such as is contained in an OTA Report or Technical Memorandum, nor does it present options for Congress to consider.

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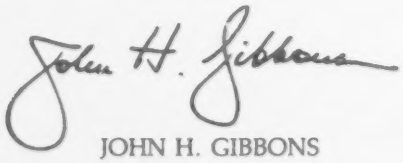
Foreword

Technology exerts a powerful influence over the lives of everyone, making life easier, more fulfilling, but sometimes more painful and frustrating. This is especially true for people with disabilities. The appropriate application of technologies to diminishing the limitations and extending the capabilities of disabled and handicapped persons is one of the prime social and economic goals of public policy.

The Federal Government is deeply involved in programs that affect the development and use of technologies for disabilities. Congress and other institutions have been increasingly interested in how well programs that directly develop technologies and support their use have been performing. The Senate Committee on Labor and Human Resources requested the Office of Technology Assessment (OTA) to conduct a study of technologies for handicapped individuals. That study examined specific factors that affect the research and development, evaluation, diffusion and marketing, delivery, use, and financing of technologies directly related to disabled people. The problems and processes of the development and use of technologies were analyzed in the context of societal allocation of resources and the setting of goals for public policy. The main report of the study *Technology and Handicapped People* was released in May 1982.

This case is background paper #1 of the study. A number of case studies will be published as part of the assessment, and each will be issued separately. The case studies were commissioned by OTA both to provide information on specific technologies and to gain lessons that could be applied to the broader policy aspects of technology and disability.

Drafts of each case study were reviewed by OTA staff; by members of the advisory panel to the overall assessment, chaired by Dr. Daisy Tagliacozzo; by members of the Health Program Advisory Committee, chaired by Dr. Frederick Robbins; and by numerous other experts in medicine, disability policy, Government, economics, public interest and consumer rights, and rehabilitation engineering. We are grateful for their assistance. However, responsibility for the case studies remains with the authors.



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OTA Note

These case studies are authored works commissioned by OTA. Each author is responsible for the conclusions of specific case studies. These cases are not statements of official OTA position. OTA does not make recommendations or endorse particular technologies. During the various stages of review and revision, therefore, OTA encouraged the authors to present balanced information and to recognize divergent points of view.

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1.
Introduction

1. Introduction

The OTA study *Technology and Handicapped People* concentrated on an examination of technologies developed for and used by people with handicaps. An alternative, or complementary focus, would be on technologies designed to prevent handicaps. There are literally hundreds of prevention technologies that constitute familiar aspects of 20th century American life. Many prevention technologies have derived from scientific research; the vaccines that prevent crippling childhood diseases are among these. Others represent a more prosaic application of common sense to everyday problems; an obvious example is the ubiquitous rubber bathtub mat. Some prevention technologies require the installation of elaborate safety equipment, such as that found in a nuclear powerplant, others require only the installation of a simple idea in people's minds—e.g., the advice not to drink and drive.

Regardless of their diverse technical characteristics, all prevention technologies can be viewed in a common perspective vis-a-vis the class of technologies designed to treat, restore, rehabilitate, and palliate handicapped individuals. Prevention technologies complement these "after-the-fact" technologies in the battle to ameliorate the consequences of handicaps. But prevention technologies also compete with treatment technologies, for a primary goal of the former is to obviate the need for the latter. Thus, physicians can exhort their patients not to smoke, or years later they can attempt to assist them to learn to live with emphysema.

Obviously, from a humane perspective, society wants to prevent all preventable handicaps. But here, as in so many other desirable human endeavors, practical considerations enter—in particular, what will prevention cost? In the coldest of analytical perspectives, the purely economic costs of preventing handicaps can be compared with the purely economic costs of dealing with preventable handicaps after they are realized. But the challenge of social resource allocation decisionmaking calls for a more complex and somewhat "warmer" cost-benefit calculus, one which blends the economic and humanitarian concerns. In the effort to minimize the adverse consequences of handicaps, analysts must develop measures (or at least concepts) of social cost which incorporate both pecuniary and nonpecuniary costs, which add the costs of suffering to the costs of materials.

The purpose of this background paper is not to develop such a social cost-benefit calculus, nor even to array the attributes of alternative prevention and treatment technologies in a comparative framework. Rather, the paper is intended merely to complement the main body of the OTA study by introducing the prevention perspective through a case study of a single prevention technology. It is hoped that this will enrich policymakers' deliberations, implicit or explicit, on the social costs and benefits of alternative strategies for dealing with the problems of handicaps.

This case study examines issues in the debate on whether passive restraint systems—air bags and automatic belts—should be required in all new automobiles sold in the United States. In 1977, Federal Motor Vehicle Safety Standard (FMVSS) 208, as amended, decreed that all new cars would have to have a passive restraint system capable of meeting a 30-mph crash performance requirement by September 1, 1983 (1984 model year), with phase-in beginning with the largest 1982 model cars by September 1, 1981.

On April 9, 1981, the National Highway Traffic Safety Administration (NHTSA) announced a delay of 1 year in implementation of FMVSS 208, and new hearings were held in August 1981 to consider whether the (delayed) rule should be put into effect or one of three alternatives should be adopted. Two of the alternatives involved a reordering of implementation dates for the various sizes of cars; the third involved elimination of the passive restraint requirement.

*NOTE: The writing of this background paper on passive restraints in automobiles was completed in May 1982. As the paper went to press in September 1982, the situation regarding passive restraints had been further altered by court decisions but had not yet been finally resolved.

On October 29, 1981, NHTSA announced that it was rescinding the requirement altogether. Lawsuits to reverse the decision have been filed, and congressional action with a similar intent has been threatened. Thus, though the passive restraint requirement has been eliminated by administrative fiat, the issue is not entirely dead.

Congressional hearings have been held only once since the 1977 decision, but several agency hearings have been held, and debate has raged over issues as diverse as effectiveness, safety, cost, and individual liberty. The automobile, the quintessential symbol of American affluence and individualism, has thus become a battleground for a major political issue of the early 1980's—governmental regulation.

The preceding paragraph should suggest the multidimensional significance of the outcome of the Federal rulemaking, but the raison d'être of passive restraint systems links the debate integrally into a consideration of technology and handicapped people: motor vehicle accidents annually kill more than 50,000 Americans (over half of them frontseat occupants of vehicles) and inflict disabling injuries (ranging from temporary and minor to permanent and serious) on an additional 2 million people. Automobile accidents are the leading cause of death and accident-produced handicaps among young people. Some analysts have estimated that passive restaint systems could prevent up to half of the deaths of frontseat occupants and over 100,000 moderate to critical injuries each year.

The remaining chapters of this paper explore the issues and evidence in the passive restraint system debate. Chapter 2 considers the nature and extent of the automobile safety problem, examining accident, death, and injury data and reviewing the record of automobile safety standards and devices, including the current ("active") seatbelt system. Chapter 3 offers a glimpse at approaches to improving the use of passenger restraints by means other than mandating passive restraints. Attention then turns in chapter 4 to a description of the two passive restraint systems—air bags and automatic belts—and a presentation of data on their estimated costs, safety, and effectiveness in reducing deaths and disabilities. The fifth chapter reviews and compares cost-benefit analyses of these systems. Chapter 6 identifies and discusses the philosophical and ethical issues related to mandating passive restraint systems. Concluding thoughts are presented in chapter 7.

In closing this introduction, it seems worthwhile to reflect momentarily on a peripheral but important theme—20th century technology and its impact on health (a theme which is well illustrated by the case of the automobile). Certainly, overall, technological developments in this century have enhanced the quality of life and added years to its average duration. Many developments have directly attacked common sources of disability and mortality (polio vaccine is one prominent illustration), while other developments have reduced health hazards indirectly (for example, the affluence bred of modern industrialization has improved our diets and thereby rendered us more resistant to disease). But 20th century technology has not invariably reduced health hazards. Rather, the history of new technology is one of continual redefinition of the types and sources of risks to health, with new hazards replacing old, and the gains generally exceeding the losses: the overall trend in disability and mortality has been downward.

The automobile serves as a prime example of the complexity of modern technology's role in health. Its invention introduced an era in which the time distance between a health crisis and curative medical care would be reduced by critical minutes, in which timely rescue from a burning building would become increasingly feasible, and in which distribution of life-sustaining food and medicine would occur ever more rapidly and inexpensively. Accompanying these health benefits of motor vehicles, however, have been the significant health costs of street and highway travel, and the deaths and injuries which reflect the size, structure, and velocity of the vehicles, as well as characteristics of the roads and of the operators of the vehicles. The disproportionate impact of motor vehicle accidents on the young is particularly tragic, as thousands of lives are cut short in their prime and healthy bodies are committed to decades in beds and wheelchairs. The economic costs of treatment and rehabilitation as well as lost future productivity are substantial. The emotional toll is enormous. It is toward reducing these burdens that the technology of passive restraints is directed.

2.
Automobile Safety Problem

2. Automobile Safety Problem

HEALTH CONSEQUENCES OF ACCIDENTS*

In 1979, motor vehicle accidents killed 51,900 Americans, including 9,400 pedestrians and 42,500 nonpedestrians. The vast majority of the latter group, 28,900, were occupants of passenger cars; 6,700 were in trucks, and 3,700 were on motorcycles. An additional 2 million people received disabling injuries. All told, there were 18.1 million accidents involving 29.7 million vehicles, the large majority of which resulted primarily in property damage or nondisabling injuries. One in twelve vehicles registered in the United States was involved in an accident, and a similar ratio characterized the fraction of the population involved in an accident. Additional consequences included the following:

- 3.5 million hospital bed-days beyond initial emergency care;
- 35,700 person-years of work effort lost; and
- an estimated $35.8 billion in economic costs,** almost half of the total costs of all types of accidents.

The motor vehicle accident toll is not distributed proportionately among the population. Over 40 percent of accident-involved drivers are under the age of 25, an age group constituting just under 23 percent of licensed drivers. Table 1 shows the most tragic consequence of this phenomenon: the motor vehicle death rate for 15- to 24-year-olds is twice the national average and five times that of younger children. Table 2 demonstrates further that there is a strongly unequal sex distribution of motor vehicle fatalities, with male drivers' age-specific death rates exceeding those of females by a factor of from 2.4 to 4.6. The *worst* rate for females (women under the ages of 20) is less than the *best* rate for males (men 55 to 64 yers old). More than 1 in every 100 15-year-old boys will die in an accident before the age of 25, a death rate 20 times higher than that attributable to polio at its worst (13).*

Unfortunately for the purposes of this study, there are no good national data on the types and

Table 1.—Motor Vehicle Fatalities in the United States by Age, 1979

Age	Number of fatalities	Fatality rate[a]
<5 years	1,500	9.6
5 to 14 years	2,900	8.4
15 to 24 years	18,900	45.7
25 to 44 years	15,000	25.0
45 to 64 years	7,900	18.0
65 to 74 years	3,000	19.6
≥75 years	2,700	28.8
Total	51,900	23.6

[a]Deaths per 100,000 population.

SOURCE: National Safety Council, *Accident Facts* (Chicago: NSC, 1980).

Table 2.—Motor Vehicle Fatality Rates of Licensed Drivers, by Sex and Age

	Fatality rate[a]	
Age	Males	Females
<20 years	131.8	35.1
20 to 24 years	107.9	23.6
25 to 34 years	69.1	15.2
35 to 44 years	52.1	13.7
45 to 54 years	44.6	12.0
55 to 64 years	36.4	12.5
≥65 years	37.0	15.6

[a]Deaths per 100,000 population.

SOURCE: National Highway Traffic Safety Administration, *Highway Safety Facts 3* (Washington, D.C.: Department of Transportation, 1978).

*Data in this section are from the National Safety Council (31) and the National Highway Traffic Safety Administration (29). It should be noted that many accident-related data are estimates and that numerous data inconsistencies are found in the literature on motor vehicle accidents.

**This figure includes lost wages, medical expenses, insurance administration costs, and property damage. It does not include police, fire, and court expenses, the value of lost cargo on commercial vehicles, etc. (31). A recent independent study estimated the costs of motor vehicle deaths and injuries at $20 billion (11).

*Age-specific motor vehicle death rates are in part a function of exposure. For example, the number of passenger-miles per year varies from 16,000 for males in their early thirties to under 3,000 for elderly women. From their mid-twenties to early sixties, men ride from 50 to 100 percent more passenger-miles than women. As a result, fatality rates per 100 million passenger-miles by age differ from the simple age-specific fatality rates. The young males' rates remain the most socially alarming, but the highest rates per 100 million passenger-miles belong to the very elderly (over 75) (6).

numbers of handicaps that result from motor vehicle accidents. The National Highway Traffic Safety Administration (NHTSA) is trying to refine data collection to produce such information, but today's data on disabilities do not permit a useful assessment (34). Currently, data indicate severity of injury but do not follow through on the outcomes of injuries.

Table 3 presents the percentage distribution of injuries in a recent NHTSA sample by injury severity. The data indicate that over 70 percent of all injuries are scored as minor on the Abbreviated Injury Scale (AIS), a common index of injury severity. Under 12 percent of injuries are in categories (AIS 3 to 5) in which survival is probable or possible and in which serious handicaps could be a result. Given the total number of injuries, however, this relatively small percentage still represents many tens of thousands of people. Furthermore, moderate injuries (AIS 2) can also result in disabling handicaps. Thus, while reliable data on accident-produced handicaps are not available, injury severity data suggest the substantial probable burden.

Despite the "bad news" contained in the above motor vehicle accident data, there is also good news. During the 1970's, total motor vehicle deaths declined 7 percent—dropping from 55,791 deaths in 1969 to 51,900 in 1979. Given growth in the population and in the number of registered vehicles, the decline in death rates was quite dramatic. For example, the death rate per 10,000 registered vehicles dropped 37 percent, from 5.19 to 3.26. In 1979, the death rate per 100 million vehicle-miles stood at an all-time low of 3.4; in the 1940's and earlier, that rate was in the teens. The death rate per 100,000 population fell by 15 percent over the course of the decade; this included a 10-percent decrease in the 15- to 24-year-old age category, the smallest age-specific decline. A variety of factors contributed to these improvements, including the national 55-mph speed limit implemented in 1974, the increasing price of energy in the mid to late 1970's, and automobile safety features (47). We now turn to a look at the record of Federal governmental regulation of automobile safety.

Table 3.—Distribution of Injuries by Injury Severity

AIS Code no.	AIS Definition	Percentage of persons	Percentage in class surviving
1	Minor	71.1	99.989
2	Moderate	16.4	99.878
3	Serious, not life threatening	8.1	99.158
4	Severe, life threatening	2.2	91.978
5	Critical	1.5	41.799
6	Maximum injury, virtually unsurvivable	0.8	0.000

SOURCE: S. Partyka, "Effects of Traffic Accident Injuries on the Workforce Estimated From NCSS and NASS Data" (Washington, D.C.: National Highway Traffic Safety Administration, National Center for Statistics and Analysis, June 1981).

RECORD OF FEDERAL SAFETY STANDARDS

As substantial as the accident toll is today, there is evidence that it would have been considerably greater in the absence of existing Federal Government safety regulations. Analyzing data from the Fatal Accident Reporting System of NHTSA, Robertson (37) has estimated that for the years 1975 through 1978, some 37,000 fewer deaths occurred than would have been expected in the absence of the Federal safety standards.

Robertson observed a total death rate of 5.5 persons per 100 million vehicle-miles for cars not subject to safety regulations, but a rate of only 3.4 for cars meeting the Federal safety standards. A differential characterized all classes of victims (including pedestrians, motorcyclists, and pedalcyclists), but occupants of automobiles meeting the standards realized the greatest benefit, with a death rate of 1.5 per 100 million vehicle-miles compared with 2.9 for occupants of vehicles not subject to the standards.

Robertson did not examine the impact of safety standards on injuries and disabilities, but a qualitatively similar benefit would be expected.* Other studies also have documented decreased oc-

*It is possible that a safety standard which reduced deaths might thereby result in increases in nonfatal injuries. The evidence gathered to date, however, suggests that reductions in fatal and nonfatal injuries go hand-in-hand.

cupant deaths and nonfatal severe injuries associated with State and Federal safety regulations (7,16,21,35).

Most Federal safety standards are technological and fall into two categories: vehicle crashworthiness and crash avoidance. Table 4 lists prominent examples of existing Federal Motor Vehicle Safety Standards (FMVSSs) intended to protect automobile occupants solely in the event of an emergency; these standards are similar in intent to passenger restraint systems. It should be noted that nontechnological standards can have a comparable or greater effect in reducing the accident health toll; the national 55-mph speed limit stands as perhaps the most prominent example. In a 1979 study, the National Safety Council (NSC) estimated that there would have been an additional 5,500 motor vehicle accident deaths per year were it not for reduced speeds and a narrower speed distribution, both of which are attributable primarily to the 55-mph law. NSC also estimated that if all States had raised their speed limits to 65 or 70 mph in 1978, an additional 5,200 to 7,800 deaths would have resulted that year (47).

The magnitude of the remaining accident health toll suggests the considerable potential for using additional technology to further decrease highway-produced deaths and disabilities. High usage rates of passenger restraint systems alone could reduce the toll by half (see ch. 4). Belted occupants of automobiles experience 50 percent fewer highway deaths than unbelted occupants (40)—yet it is estimated that only 10 to 15 percent of the population wears seatbelts, and the percentage has been falling in recent years (15). Automatic (i.e., passive) restraint systems are advocated precisely because of this failure of the vast majority of the population to use manual (i.e., active) belts. The reasons for, and implications of, the nonuse of manual belt systems are considered further below.

Table 4.—Existing Federal Standards Intended To Provide Protection in the Event of an Emergency

FMVSS	Title	Automatic performance required
105-75	Hydraulic brake systems	Requires split brake system for redundancy if primary system fails
110	Tire selection and rims	Rim must retain tire from 60 mph to stop after rapid deflation
111	Rearview mirrors	Breakaway inside mounting for mirror
201	Occupant protection in interior impacts	Contactable interior surfaces must be padded or meet performance requirements with headform impact at 15 mph
203	Impact protection for the driver from the steering control system	Steering assembly must absorb driver impacts under controlled crash criteria
205	Glazing materials	Windshield has a high penetration resistant inner layer
212	Windshield mounting	Requires windshield mounting retain specified periphery of windshield in crashes
215	Exterior protection	Provides vehicle protection in certain crash impacts
301	Fuel system integrity	Provides protection against fuel systems rupture and leakage in crashes

SOURCE: W. Haddon, Submission of Documents to W. Coleman, Jr., Secretary, Department of Transportation, Washington, D.C., Sept. 17, 1976.

MANUAL SEATBELTS

Front-lap seatbelts were first installed in all cars as standard equipment in 1964, when 14 States required them (41). By the late 1960's, lap and shoulder belts were required as standard equipment on all new cars sold in the United States. Thus, almost all cars on the road today are equipped with lap or lap/shoulder belts; the vast majority have the lap/shoulder combination. Studies indicate that, when worn, belts reduce the risks of death and serious injury by 50 percent or more (28,40). Although most people may not be familiar with the precise statistics, virtually everyone is aware that "seatbelts save lives," as the publicity slogan put it years ago.

Yet, according to recent observations of manual belt use, only 11 percent of drivers wear their belts (15). Usage rates have fallen in recent years, following a brief period of increases in the mid-1970's. The increases in the mid-1970's may have been attributable in part to the ignition-interlock systems that were installed on 1974 and some 1975 model cars. The interlock systems provoked a loud and angry public response as drivers found themselves unable to start their cars when they placed cargo on the passenger seat (e.g., groceries or the family dog) that exceeded the weight minimum which activated the system. The congressional response was to prohibit the Department of Transportation from requiring the system on later cars (41).

Table 5 shows how belt usage varied in 1977-78 by automobile model year. The American Automobile Association claims higher usage rates in some of the (then) newer model cars with improved belt systems (13). Table 6 indicates how belt usage varied by sex, region of the country, and car size.

The result of such low usage rates is that manual belts in cars currently reduce the fatality and serious injury rates by less than 10 percent. Thus, a tremendous potential for saving lives and preventing injuries is going unrealized, despite the ready accessibility of the technology and the relative ease of its use.

Table 5.—Seatbelt Usage in 1977-78 by Car Model Year

Car model year	Usage (percent)		
	Lap only	Lap and shoulder	Total
1964-67	8.9	—	8.9
1968-71	8.5	2.4	10.9
1972-73	12.7	4.2	16.9
1974	2.7	14.4	17.1
1975	1.7	12.7	14.4
1976	1.4	12.2	13.6
1977	1.1	12.2	13.3
1978	1.2	12.5	13.7

SOURCE: National Highway Traffic Safety Administration, *Occupant Protection Program Progress Report No. 2* (Washington, D.C.: Department of Transportation, April 1979).

Table 6.—Seatbelt Usage in 1977-78 by Sex, Region, and Car Size

Characteristic/Car model years	Total usage (percent)
Sex, 1964-78:	
Male drivers	12.6
Female drivers	16.4
Region of country, 1964-78:	
West coast	18.3
All other regions (average)	11.4
Car size, 1976-78:	
Subcompact	19.5
Compact	12.5
Intermediate	10.3
Full	9.6

SOURCE: National Highway Traffic Safety Administration, *Occupant Protection Program No. 2* (Washington, D.C.: Department of Transportation, April 1979).

What accounts for the extremely low usage rates? Two factors invariably cited in polls are discomfort and inconvenience (28), although a survey sponsored by General Motors (GM) has identified other factors as being of greater significance (e.g., fear of being trapped in a vehicle) (18). The issue of discomfort reflects belts' pressuring or abrading hips, chests, and necks and creating an unpleasant sense of confinement or restriction of movement. For some people, inconvenience refers simply to the minor effort involved in buckling a well-functioning belt system, while for others it relates to difficulties in retracting the belts or latching or releasing them.

In a study of its own, NHTSA concluded that many of the complaints about belts were well founded. A representative sample of Detroit-area drivers identified moderate or serious problems with comfort or convenience in all of the 30 cars tested, with the best-performing car cited as having a problem in 35 percent of the trials and the worst-performing car cited in 85 percent. In anticipation of automatic belt systems, NHTSA has been developing comfort and convenience specifications intended to address these problems (28). If the GM-sponsored study is correct, however, improvements in comfort and convenience may not lead to significant increases in belt usage (18).

The decision not to wear a belt presumably reflects a judgment that the disutility associated with discomfort, inconvenience, or other factors outweighs the perceived utility of reducing risk. Arnould and Grabowski (3) offer two related explanations for why this judgment is so common.

The first explanation, referred to as the "insensitivity-to-low-probabilities" hypothesis, suggests that for very low-probability events (such as a serious car crash on a single outing), individuals become insensitive to the high potential cost of not protecting themselves and indeed may not comprehend the meaning of the tiny probability; instead, they respond primarily to the unlikelihood of the event.

Arnould and Grabowski discuss a study (44) which illustrates the principle: two groups of experimental subjects were given data on the probability of experiencing a fatal or disabling accident. One group was given the figures for a lifetime (50 years) of driving (a 1-in-100 chance of a fatal accident and a 1-in-3 chance of at least one disabling injury), while the other group received the same information calculated on a per-trip basis (where the odds of the accident outcomes are minuscule). Compared with the latter group, the group given the lifetime figures responded by indicating a much greater increase in expected seatbelt usage and a greater disposition toward seatbelt laws.

Arnould and Grabowski also present evidence that people significantly underestimate their risk of involvement in an automobile accident. For example, a recent survey (45) queried: How likely do you think it is that you will be involved in an automobile accident of any kind in the next year? Fewer than a quarter of the survey respondents selected an answer equal to or greater than the actual societywide average, roughly 1 in 10. A majority selected odds of 1 in 100 or smaller still.

The second explanation for the judgment that the disutility of buckling up outweighs the utility of protection is that the expected value of the protection for any given trip is extremely low, owing to the low probability of a serious accident, and thus, a driver (or passenger) simply may value avoidance of discomfort or inconvenience more than protection. This will be particularly true if, as above, the individual significantly underestimates the probability of an accident.

Arnould and Grabowski estimate the annual per-person benefits of buckling up at between $38 and $78 (in 1975 dollars) and state that, at prevailing wage rates (the assumed opportunity cost of time), this amount must exceed the time costs of buckling up. Hence, they conclude that a rational weighting of costs and benefits cannot explain the failure of so many people to wear their seatbelts. The authors acknowledge that "there may be significant discomfort costs to some individuals to wearing seatbelts." Nevertheless, they suggest, "it would seem hard to argue that [this] would so change the . . . benefit-cost calculus to explain the 80- to 90-percent current nonutilization rate of seatbelts."

While it is agreed that discomfort costs could not explain the entirety of nonutilization, it could be argued that they might explain much of it, particularly if "discomfort" is defined to include the psychological discomfort of those who fear being trapped in their cars by belts. Certainly, many riders who experience discomfort from seatbelts would accumulate hundreds of hours of discomfort if forced to wear them, and one would not need to value discomfort time highly to conclude that nonuse was rational behavior for these individuals.

Numerous characteristics differentiate belt wearers from nonusers (41). The latter tend to have less education than the former, rate belts as more uncomfortable and inconvenient, and are more likely to be smokers. The victims of serious

crashes are less likely to wear belts than people not involved in serious accidents, especially in the case of youthful drivers and drivers under the influence of alcohol. Furthermore, unbelted drivers tend to follow the cars in front of them closer than do belted drivers. Collectively, all of these characteristics suggest that unbelted drivers are less risk-averse, or perhaps more risk-loving, than their belted counterparts.

Whatever the explanation, the fact remains that only a small minority of automobile occupants choose to wear seatbelts. The consequence in human destruction is tragic.

3.
Alternatives to Mandatory Passive Restraint Systems

3. Alternatives to Mandatory Passive Restraint Systems

Prior to its rescission, Federal Motor Vehicle Safety Standard (FMVSS) 208—the requirement that all new cars come equipped with passive restraint systems—represented a policy judgment that passive restraints were the best way to address the failure of the vast majority of Americans to wear their (manual) seatbelts. But passive systems are not the only option; other alternatives have been suggested and some have been tried.

Advocacy for the passive restraint alternative reflects in part the experienced or predicted failure of the other alternatives. In this chapter, the alternatives are briefly identified, and the evidence that relates to their effectiveness is presented. (Ch. 4 considers the nature, effectiveness, and costs of passive restraint systems.) It should be noted that the alternatives listed below are by no means mutually exclusive:

1. Do nothing—i.e., leave the current manual lap/shoulder belts in place, leave the decision of restraint to the individual automobile occupant, and do nothing to promote the use of manual belts.*
2. Actively promote the use of manual belts through media campaigns and other educational efforts. This is one of the options the Reagan administration has favored.
3. Pass legislation requiring the wearing of seatbelts.
4. Require a "technological fix" that forces manual belt use (e.g., the previously tried ignition-interlock system).
5. Offer economic incentives to automobile occupants to wear their seatbelts.

*A still more laissez-faire option would be to eliminate the requirement that cars have manual belt systems as standard equipment, leaving purchase and installation of belts as a buyer option. There are sound theoretical reasons to oppose this possibility (discussed in ch. 6 below), in addition to the political uproar it would create.

DO NOTHING

This alternative has few proponents in the political arena. Lacking some bone tossed in the direction of promoting passenger restraint, the "do nothing" alternative must be dismissed as being of unlikely political viability.

INFORMATION/EDUCATION CAMPAIGN

The theoretical appeal of this alternative is considerable, and the Reagan administration has adopted this approach as its policy to promote use of passenger restraints. Provision of information—education—is the conceptually appropriate approach if one perceives the problem of belt nonuse as resulting from riders' ignorance of the true risks of automobile travel and/or the true effectiveness of wearing belts. Public education addresses the public's information deficit and still preserves the freedom of (informed) riders to choose not to be restrained (see also ch. 6).

Borrowing from related health education experience, one might be tempted to conclude that major publicity efforts could increase the voluntary use of seatbelts. For example, there is evidence that the antismoking campaign of the past nearly two decades has had a substantial impact on cigarette smoking (49), and specifically,

that the major broadcast media antismoking campaign of 1968-70 significantly reduced cigarette consumption (48). Unfortunately, however, the evidence on whether the smoking experience generalizes to the case of seatbelt use is not encouraging and is at best ambiguous.

Influenced by evidence such as the following, a number of experts (30,41) have concluded that information/education campaigns are unlikely to significantly increase belt usage. In 1968, the National Safety Council (NSC) received $51.5 million worth of media public service announcement time to encourage seatbelt use; similar NSC campaigns were mounted in 1972 and 1973, yet interview data indicated no change in reported seatbelt usage (15). Several controlled experiments and quasi-experiments with media promotion of belt use also have failed to produce increases in use (8,43). The American experience is echoed by experience in Canada, Great Britain, and France: major publicity campaigns either did not increase belt use at all or, at best, they increased use slightly and only in a transitory manner; i.e., campaign-induced increases disappeared soon after conclusion of the campaign (15).

Proponents of the information/education approach claim that it has not been given a fair trial, that more sophisticated understanding of the factors influencing seatbelt usage will permit development of more effective education and publicity packages. They also argue that an effective campaign requires a long-run approach, with successive education and information efforts reinforcing preceding ones and gradually converting nonbelt users into users.

However, even the most optimistic assessment suggests that an "all-out" campaign could not boost usage rates to greater than 40 percent (13). Thus, if one's objective is to reduce preventable motor vehicle fatalities by as much as possible, this alternative clearly cannot be relied on by itself.*

*The difficulty of promoting truly informed decisionmaking—the objective of this alternative—is more substantial than one might think at first. As Arnould and Grabowski (3) demonstrate, people's understanding of accident risks is poor, and the statistical or probabilistic nature of such risks constitutes a subtle message to communicate to a comprehending public. This is illustrated by evidence that the public's understanding of the health hazards of cigarette smoking is remarkably unsophisticated despite nearly two decades of publicity, education, and public discussion of those hazards (26).

MANDATORY SEATBELT-USE LAWS

This alternative—passing mandatory seatbelt use laws—has precedents around the world in well over a dozen countries. In Australia, New Zealand, Canada, Sweden, and West Germany, mandatory belt laws have been in effect for several years and prelaw and postlaw belt-usage data are available. The first such law, in the State of Victoria, Australia, produced belt-use rates of 70 to 80 percent and accounted for reductions in fatality rates of 20 percent in urban crashes and 10 percent in rural crashes. In the Provinces of Ontario and Quebec in Canada, "weakened" laws (i.e., exempting shoulder belt use because of the public's concern about discomfort) have produced usage rates in the vicinity of 40 to 50 percent. Four years after passage of its belt-use law in 1972, New Zealand was reported to have a compliance rate of from 80 to 90 percent. An 80-percent rate has been reported for Sweden; and in West Germany, observed rates have ranged from 45 to 80 percent (9).

No U.S. State has adopted a seatbelt law applying to drivers. The traditional American sense of independence normally would create significant opposition to such laws—a poll 4 years ago found more than three-quarters of respondents opposing them (13)—and the antiregulatory climate of the early 1980's presumably would increase the level and intensity of opposition. As a representative of the Consumer Federation of America stated (13):

> All too often State legislators, faithfully reflecting the sentiment of the people in the State, see mandatory belt legislation as an outrageous and unnecessary intrusion into people's lives. Whether one agrees with that view or not, it is a sentiment that is prevalent in the large majority of our States.

This mentality is reflected in the fact that over half of the States have recently repealed laws requiring motorcyclists to wear helmets, despite solid evidence that helmet laws save lives (25,51).

Several States—including Tennessee, Rhode Island, and Michigan—have adopted laws requiring that children be restrained in moving automobiles. The laws often include exemptions or exceptions (e.g., permitting babies to be unrestrained when nursing). Observational studies conclude that belt-usage rates by children have increased, though they remain low overall (approximately one-third) (41).

Mandatory belt-use laws are potentially the most effective approach to ensuring passenger restraint. Experience in other industrialized countries suggests that a mandatory law might result in usage rates exceeding those achievable with passive seatbelts, because so many passive belts would be detached. Nevertheless, in today's political climate in the United States, mandatory seatbelt-use laws seem unrealistic. It also should be noted that this assessment of belt laws has utterly ignored the question—and cost—of enforcing the laws.

"TECHNOLOGICAL FIX"

Also unlikely is the "technological fix" alternative—unless a system can be designed that is technically superior to, and much more publicly palatable than, the ignition-interlock system found in 1974 (and some 1975) model cars. The technical problems with that system and the resulting public furor led to the elimination of the Federal requirement of the system.

A sequela of that experience was that FMVSS 208 prohibited use of an interlock system in any passive restraint system developed to satisfy the (then-existing) requirement. Certainly, it is possible that passive belt systems could be developed which would make permanent, or even temporary, disconnecting difficult or inconvenient, and this might have a marginal impact on passive belt use. But given the public's clear opposition to evident and burdensome "technological fixes," manufacturers and the Government seem unlikely to go this route.

ECONOMIC INCENTIVES

The remaining alternative—offering economic incentives to wear manual belts—has not been tried directly, though a few insurers do offer premium discounts of up to 30 percent on medical or personal injury protection coverage for cars equipped with passive restraints (air bags or automatic seatbelts) (3). It is conceivable that premium discounts or increases in coverage could be granted users of manual belts, but the problem of verifying compliance is not a minor one. Similarly, insurers could offer positive or negative benefit incentives. For example, medical payments could be increased for belt-wearing accident victims (an approach adopted by at least one insurer), or payments could be conditioned on belt use at the time of an accident.

If the compliance problem could be resolved (mechanical solutions are conceivable), the potential for the premium approach is intriguing. For a car with automatic belts, Nationwide Insurance has estimated premium savings of roughly $20 per year. Over the lifetime of a car, this translates into a present discounted value of $150 (33). Since many automatic belts are disconnected,* assur-

*A survey found a disconnect rate of 22 percent among owners of VW Rabbits equipped with automatic belts. The finding that owners of Rabbits with manual belts tend to use their belts more frequently than the average automobile owner suggests that the automatic belt disconnect rate under a mandatory passive restraint law might be greater than 25 percent. The rate could be considerably greater. In particular, the automatic-belt Rabbits have had an interlock system, so disconnection requires action after the car has started —perhaps a more active form of passive-belt rejection (23).

ance of compliance with manual belts should be worth at least as much as the initial presence of automatic belts. Thus, the lifetime insurance value of buckling up might prove to be a significant incentive.

Even if the insurance incentive "worked," it seems unlikely that it would raise effective restraint rates high enough to satisfy people who want to see maximum reduction of the highway death and disability toll. Aside from paternalism, an argument grounded in the existence of negative externalities suggests that self-selected compliance rates will be too low from a social point of view (see ch. 6). Furthermore, the economic incentive approach would take time to achieve widespread effect—compliance technology would have to be developed and installed, insurance companies would have to be sold on the desirability (and amount) of discounts, etc. Despite these drawbacks, the incentive approach would seem to warrant more attention than it has received to date. To my knowledge, it is not now, nor has it been, an option under serious policy consideration.

This chapter's review of the policy alternatives should suggest one of the reasons many people concerned with automotive safety have been so supportive of passive restraint systems: for one reason or another—be it effectiveness or political acceptability—each of the alternatives, considered individually, has significant drawbacks. There is a school of thought that advocates a mix of several of these alternatives as a cost-effective means of achieving effective passenger restraint (9,18). Given the recent demise of FMVSS 208, it seems probable that more attention will be directed toward a multiple-approach strategy.

4.
Passive Restraint Systems: The Bag and the Belt

4. Passive Restraint Systems: The Bag and the Belt

BACKGROUND

There are only two major passive restraint systems: air bags (or cushions) and automatic belts. Table 7 identifies their relative strengths (many of which are discussed in this chapter), but the important point is that, when used properly, both passive restraint systems are quite effective in reducing the risk of death and serious injury.

Technically, the automatic belt system is quite simple. Most systems in operation consist of a single shoulder belt (a "two-point system") that crosses the rider automatically upon entry into the car, and a padded knee panel below the dashboard to provide added protection. Automatic belts with a lap as well as a shoulder component (a "three-point system") have also been designed. Some systems offer automatic shoulder belts and manual lap belts. Close to half a million automatic belt systems are currently on American roads, almost all of them in VW Rabbits and Chevrolet Chevettes, offered as part of option packages.

Air bags consist of deflated bags situated in the steering wheel (driver) and glove compartment area (passenger) sides which inflate virtually instantaneously when front end or dashboard sensors detect crash forces substantial enough to be harmful. Different systems have different inflation mechanisms, and all include ancillary equipment (e.g., knee restraints to prevent riders from sliding under bags, a readiness monitor, and an indicator light) (28). Altogether, over 10,000 air-bag-equipped cars have accumulated over a billion miles on American roads since they first appeared in 1972.

Table 7.—Relative Strengths of the Two Passive Restraint Systems

Air bag	Automatic belt
Less obtrusive	Less expensive
Less uncomfortable	No chemicals involved
Greater protection in most serious accident situations (particularly when used with manual lap belt)[a]	Potentially greater protection in some accident situations[a]
Less likely to be disconnected	Redeployment following emergency use less expensive

[a]See the discussion of safety and effectiveness below.

This more complex technology has a history which dates back 30 years. In 1952, the first of several patents for automatically inflating air cushions was filed. Federal Government interest dates from 1968, when prototype development became sufficiently advanced to consider large-scale application in the near future. In 1969, the National Highway Safety Bureau (NHSB, predecessor of the National Highway Traffic Safety Administration, NHTSA) announced a proposed rulemaking for an "Inflatable Occupant Restraint System," with an initially proposed effective date of January 1, 1972. This marked the beginning of a longstanding adversarial relationship between automobile manufacturers and the Department of Transportation (DOT) which saw dozens of debates over the effectiveness and cost of passive restraints and delays in implementation of, and changes in, a passive restraint requirement.

Delay and change have occurred during each successive administration, with the Reagan administration's re-examination of the issue being the latest and most radical. The courts, Congress, public interest groups, and the media have all been active participants in the drama. The conflict has made strange bedfellows of such diverse interests as Ralph Nader and the Pacific Legal Foundation (PLF), the latter a public interest group advocating "limited government." In 1977, PLF filed suit in the U.S. Court of Appeals to block the passive restraint rule, claiming that DOT had an "insufficient basis for the air bag decision." The following year, Nader and Public Citizen, the consumer rights group, filed suit in the Court of Appeals

seeking a ruling that DOT's scheduled 3-year phase-in of restraints was illegal; plaintiffs wanted all new vehicles to have passive restraints at the same time. The Court of Appeals consolidated the suits of PLF and Nader and Public Citizen.*

Part of the regulatory debate picture has been repeated proposals by automakers to introduce air bags or automatic belts on their own. Each of these proposals has come in response to a proposed passive restraint rulemaking by the Government. As each of the proposed rulemakings was altered or delayed, often because of agency actions, occasionally because of judicial decisions, the automakers' plans were themselves altered, invariably in the direction of limiting introduction of passive restraints.

In 1970, for example, General Motors (GM) informed NHSB that it would provide air bags on all its cars by 1975, introducing the equipment as an option and then converting it to standard equipment. In 1973, GM informed DOT that it was reducing its planned production of air-bag-equipped 1974-75 cars from 1 million to 150,000 units, blaming both tooling difficulties and the Government's standard-setting process. Half a year later, a GM spokesperson told the Insurance Institute for Highway Safety (IIHS) that the figure of 150,000 was probably too high.

In fact, GM built about 10,000 air-bag-equipped cars, all large models, during the 1974-76 model years. The company then canceled production, claiming insufficient consumer demand, a claim which GM officials have acknowledged was based in part on a failure of the company to promote the technology. GM's revising its plans and departing from the air-bag-equipped automobile market followed an earlier court decision overturning a proposed NHSB air-bag rule.

A similar picture emerges in the years since the mid-1970's, with promises of air-bag-equipped vehicles repeatedly made and then scaled back or rescinded (17). Recently, GM announced the termination of its inflatable restraint program, calling the device economically infeasible (23).

Three years ago, the "Big Three" domestic automobile manufacturers and several foreign producers reported to NHTSA that they were working on belt and bag systems and intended to introduce them, as options, on several models within the next few model years (28). Even prior to the rescission of Federal Motor Vehicle Safety Standard (FMVSS) 208, several of the announced intentions had not been realized.

The technology for both bags and belts is developed and available. As is discussed in the section below, when used properly, these technologies are commonly acknowledged to work, to save lives, and prevent disabling injuries. What is less clear is whether the American car rider will wear belts, active or passive, and whether the consumer's car-buying propensity will be reduced as a result of passive-restraint-induced car price increases. This too is examined below.

*For a detailed chronology of events in air bag development, debate, and rulemaking, see *Background Manual on the Occupant Restraint Issue* (13).

SAFETY AND EFFECTIVENESS

Following a review of the evidence, William Coleman, Secretary of Transportation in the Ford administration, concluded that passive restraints "are a reliable and effective means of substantially reducing death and injuries on the Nation's highways." If air bags were installed on all cars, Coleman estimated, they "would probably save over twelve thousand lives annually and prevent or reduce in severity over one hundred thousand moderate to critical injuries per year" (13).

The precise quantitative findings can be challenged—for example, recent estimates have placed the life-saving potential of passive restraints in the vicinity of 6,000 to 9,000—but the qualitative conclusion is beyond dispute. All of the quantitative

evidence supports it and the logic is impeccable: "The principle behind an occupant restraint is that an occupant is much less likely to be injured or killed in an automobile crash if the crash forces are applied in a controlled way to the strongest parts of the human body" (28). Furthermore, proponents of passive restraints argue, occupant restraints are much more likely to be used if they are automatic (i.e., passive) than if they require action on the part of the occupant, as do today's manual belts.

Passenger restraint systems are not perfect; they reduce but do not invariably prevent deaths and injuries. Neither belts nor air bags are particularly effective in rear-end collisions, and the two technologies have different merits and liabilities in other types of crashes. In the instance of an impact on the passenger side of a car, for example, belts are effective in keeping the driver from being pitched to the side. Air bags occasionally inflate on side impact, and the passenger-side bag can then protect the driver, but inflation of the bags is uncertain. If the bags do inflate, they shield the driver from flying glass and metal and thereby afford the driver a form of protection that belts cannot offer.

The technology of passive restraints might pose hazards. Concern has been expressed about the toxicity of sodium azide, a chemical in compounds used in many air bag systems to inflate the bags. Testimony has been offered indicating that the chemicals are confined sufficiently so that car occupants are not exposed to them, either before or during deployment of a bag. NHTSA is convinced by the evidence, but is quick to point out that other, nonchemical inflation mechanisms have been developed (13).

Other concerns expressed about bags include fears that inadequately restrained children could slide beneath and be smothered by the bags, or even conceivably be thrown backwards into the rear window. There are worries that air bags might inflate spontaneously without an impact or on minor impact, thereby causing a serious accident (12). Again, the bulk of the evidence is that these are not significant problems. The track record of the more than 10,000 air-bag-equipped cars is quite impressive in this regard (13,28). There may have been isolated incidents, and might be others in the future, but the life-saving and injury-reduction potential of air bags dwarfs these adverse outcomes.

The principal problem with automatic belts is that they can be disconnected. They have to be equipped with a safety release for emergencies. For the person for whom belt-wearing is truly burdensome, passive belts can be actively disengaged either permanently or repeatedly. In effect, the individual converts the passive restraint system into an active nonrestraint system, and effectiveness goes to zero.

A common worry expressed about belts (manual or automatic) is that they may prevent a person from being thrown from a car in an accident in which remaining within the car would prove to be more damaging. This outcome might occur in rare instances, but the opposite outcome is much more probable—i.e., an unrestrained occupant is much more likely to be injured or killed by being thrown from (or around) the car than by being restrained within it.

In the remainder of this section, the evidence on the effectiveness of belts and bags in reducing death and injury is presented and discussed. The following caveats should be kept in mind in interpreting the data:

1. Air-bag field experience relates virtually exclusively to large-size and luxury cars, principally the GM vehicles produced in the 1974-76 model years. Whether this experience generalizes directly to all cars (with almost all new cars much smaller than these) remains to be seen.
2. Automatic belt experience in the VW Rabbit, the source of most relevant data, might not typify general experience once all cars were so equipped. Small-car buyers in the late 1970's exhibited a greater propensity to buckle up than did the average driver of the period: whereas average drivers buckled up only 10 to 15 percent of the time, owners of Rabbits with manual (active) belt systems wore their belts 34 percent of the time (28). Thus, in a world of passive seatbelts, there would be reason to expect a disconnect rate

in the general population greater than that of automatic-belt Rabbit owners, particularly since DOT policy could not require the kind of interlock device found in automatic-belt Rabbits (23).

3. Related to the above point, current users of passive restraint systems represent a largely self-selected group. It is possible that their motivation, particularly their concern about driving safety, differs enough from that of the overall population to invalidate generalizations based on their experience. Mitigating this concern are studies which control for accident severity before assessing the effectiveness of the restraint systems. Also, in the VW case, the passive belts were part of a luxury option package, one sufficiently expensive that it seems unlikely that people would buy the package simply to get the belts. Furthermore, evidence from claims data indicates almost identical rates of accident claims and size of damage awards for Rabbit owners with and without passive belts (3). Nevertheless, it should be recognized that victims of serious crashes are less often restrained than nonvictims (41), so the average effectiveness of restraints in a mandatory system may be less than that observed with voluntary experience.*

Subject to these caveats, the evidence is strong that both air bags and automatic belts are very effective devices for reducing death and serious injury. Different studies have employed different data bases, estimating techniques, and measures of health outcomes, making direct comparability difficult.

The most effective restraint system is the air bag combined with use of a (manual) lap belt. In 1977, NHTSA estimated this combination to be 66 percent effective in reducing fatalities, with the bag alone rated as 40 percent effective.* NHTSA estimated the effectiveness of seatbelts, when worn, at 50 to 60 percent (3). Other estimates of effectiveness range from 25 percent (12) to 79 percent (12) for the air bag and from 28 percent (12) to 72 percent (13) for seatbelts. However, with both the lowest and highest figures, biases may be exaggerating the estimates.** From the entirety of the studies, a figure in the vicinity of 50 percent seems reasonable for both passive restraint technologies when used properly.

While the effectiveness ratios are close to each other, air bags rank distinctly higher as life-saving devices for one simple reason: they are used when needed. Disconnect rates for passive belts might run 30 to 40 percent, conceivably much higher, and almost certainly would exceed 20 percent (VW Rabbit experience being estimated at 22 percent).

Many of the studies share the finding that passive restraint effectiveness decreases with a decrease in injury severity, particularly as one moves to the most minor accidents. Automatic belts and air bags are most effective in protecting against fatal and life-threatening accidents, less so but still highly effective for severe but not life-threatening accidents, less effective for moderate injuries, and least effective for minor injuries.***

NHTSA, for example, estimated that belt effectiveness drops 1 to 5 percentage points as one moves from life-threatening to non-life-threatening but severe injuries, another 1 to 5 points

*A related view is that greater protection from equipment may cause drivers to drive with greater abandon, since they feel "safer." Peltzman (35) advanced this view in an article in which he claimed that automobile safety regulations had led to a redistribution, rather than reduction, in highway deaths, with occupant deaths falling and pedestrian deaths rising. Peltzman's work has been criticized on both empirical and theoretical grounds (38).

*In studies of air bag deployments, 16 or 17 percent of occupants were wearing manual lap belts (24).

**For example, Huelke and O'Day (12) examined rural accidents and relied on a team of medical and other experts to estimate the probability of occupant survival with different kinds of restraints. Rural accidents tend to be more severe than average, which may produce a downward bias in the authors' estimates (3).

***As discussed in ch. 2, automobile accidents are categorized according to the Abbreviated Injury Scale (AIS), which runs from minor injuries (AIS 1) to fatalities (AIS 6). Attempts to utilize injury data in a comparative framework often involve manipulating AIS codes (e.g., using the root mean square of the AIS). More recently, in an attempt to combine the effects of the severity and number of injuries, an Injury Severity Score (ISS) was developed. The ISS has been shown to be highly correlated with the probability of death, length of hospitalization, and extent of disability (24).

moving to moderate injuries, and 20 to 27 points to minor injuries (3). For air bags, NHTSA estimated more precipitous drops, by 10 to 20 percentage points moving to the severe-but-not-life-threatening category, 8 to 13 points to moderate, and 8 to 22 points for minor. The air bag's effectiveness, without a lap belt worn, is rated at close to zero for minor injuries, since the bag will rarely deploy.

Mohan, Zador, and O'Neill (24), provide support for this general finding. In their assessment of the mean Injury Severity Score (ISS) for the two restraint systems and unrestrained occupants by Vehicle Deformation Index (VDI),* Mohan, et al., found that for high VDIs (considerable vehicle deformation), both restraint systems performed well: lap/shoulder belts resulted in an average ISS 55 percent below that of the no-restraint situation, and air bags scored an ISS 66 percent below the no-restraint condition. Both of these differences were statistically significant. While the small difference between the two restraint systems was not statistically significant, it was consistent with laboratory test data indicating the superiority of air bags in severe frontal crashes.

Mohan and colleagues found that for lower VDIs (less vehicle deformation), belts continued to show a considerably lower mean ISS than no restraints; air bags, however, did not. The authors explain this, at least in part, as an artifact of the accident-designation process: an accident was recorded as involving an air-bag- equipped vehicle only when an air bag deployed; at low VDIs, deployment might indicate a stronger-than-average crash force for the VDI class. Regardless of the explanation, however, the data are consistent with the finding that relative restraint effectiveness decreases with decreasing accident severity, and that air bag effectiveness decreases more rapidly—i.e., an occupant is better off wearing a seatbelt in a minor accident but perhaps better off being in an air-bag-equipped car in a severe crash. And, again, wearing a belt in an air-bag-equipped vehicle is the safest form of restraint.**

From the relationship between probability of death and ISS, Mohan and colleagues estimated the expected number of deaths per 1,000 occupants in cars in frontal crashes with VDIs of 3 to 5. Their estimates, given in percentage terms above, constitute very high estimates of belt and bag effectiveness. Nevertheless, it seems worth presenting these striking numbers: for 1,000 unrestrained occupants, the estimated deaths total 19.4; for 1,000 lap/shoulder-belt-restrained occupants, deaths equal 5.4; and for 1,000 air-bag-restrained occupants (16 percent also wearing a lap belt), the figure is 4.0. The authors caution that these estimates apply only to full-size and luxury cars. I would caution, further, that they *are* estimates, based on a general correlation between an index and an extreme outcome—death.

The different technologies have comparative advantages in the specific injury protection they confer. Table 8 presents data on the root mean square Abbreviated Injury Scale (AIS) ratings, by body region and restraint system, for occupants in frontal crashes with VDIs of 3 to 5. The data show that both air bags and lap/shoulder belts provide greater protection for all body regions (with one exception) than no restraint.

Air bags are particularly effective in reducing head and neck injuries (by 58 percent compared with no restraint) and have their greatest advan-

Table 8.—Root Mean Square AIS Ratings for Occupants in Frontal Crashes With VDIs 3-5, by Body Region and Restraint System

Body region	Restraint system		
	Air bag[a]	Lap/shoulder belt	None
Head and neck	0.5	0.7	1.2
Face	0.7	0.8	1.2
Chest	0.8	0.8	1.4
Abdominal or pelvic region	0.3	0.8	0.5
Extremities and pelvic girdle	1.1	1.2	1.8

[a]Approximately 16-percent lap belt use.

SOURCE: D. Mohan, et al., "Air Bags and Lap/Shoulder Belts—A Comparison of Their Effectiveness in Real World, Frontal Crashes" (Washington, D.C.: Insurance Institute for Highway Safety, 1976).

*The VDI is exactly what the name suggests—an index of the severity of damage to the body of a vehicle.

**A GM study in 1976 concluded that air bags' effectiveness in reducing injuries ranged from only 6 to 20 percent. An NHTSA critique of the study identified two potential sources of serious bias that led NHTSA to conclude that the data supported an effectiveness estimate of from 30 to 60 percent (28). GM has defended the methodology of its study [D. Martin, General Motors, personal communication, 1982].

tage over belts in the abdominal and pelvic regions, where belts actually perform worse than no restraint at all (though the injury severity level is not great). Belts are less effective than bags in all regions except the chest area, where they confer equal protection.

The most serious injuries occur to the extremities and pelvic girdle, with both restraint systems affording relatively less protection than in most other areas. While bags dominate belts in this analysis, it must be remembered that in the minor accidents not recorded in this table (VDIs less than 3) in which air bags do not deploy, the unbelted occupant of an air-bag-equipped car generally receives no additional protection, while the belted occupant does.

Most of the estimates presented above have been based on actual accident data; some have derived from laboratory tests and theoretical analysis. In most, though not all, attempts have been made to correct for sources of bias, differences in types of drivers, and so on. Nevertheless, it seems useful to close this consideration by presenting some unadjusted on-the-road data, numbers in the simplicity of which lies clarity.

With regard to passive belts, experience with the VW Rabbit is considerable. From 1975 through early 1981, VW produced 400,000 cars with automatic belts satisfying the requirements of FMVSS 208. These cars have averaged 0.78 deaths per 100 million vehicle-miles, compared with a national average of 2.4—a 68 percent reduction in the death rate (14). In an earlier comparison of accident-death experience in Rabbits with automatic v. manual belts, there were 51 percent fewer deaths per 1,000 car-years with the former than with the latter (28). Since some of the automatic belts were disconnected (an estimated 22 percent) and many of the manual belts were being used (about 34 percent), this difference provides an underestimate of, or at least a lower bound on, the life-saving potential of passive belt systems.*

With regard to air bags, almost all of the experience clusters at the other end of the car line: full-size and luxury cars, primarily the 10,000 to 12,000 produced by GM between 1974 and 1976. By 1979 these cars had accumulated over 700 million miles of driving on American roads. Statistical expectations for deaths and moderate to critical injuries would have been 10 and 124, respectively, yet experience showed half of these figures: 5 occupants of air-bag-equipped cars had died and 62 had received moderate to critical injuries. There had been some 200 air-bag deployments and only two known deployment failures, one attributable to a mechanic's mistakenly disconnecting the mechanism (28).

Finally, while fatality and injury data constitute the bottom line, it is interesting to note that passive restraints may be beginning to pass another acid test—i.e., their effect on automobile insurance. Beginning in the late 1970's, a few insurance companies, including Nationwide and Allstate, offered owners of passive-restraint-equipped vehicles reductions of approximately 30 percent on the portion of car insurance premiums applicable to medical (Medpay) or personal injury protection (PIP) coverage. Nationwide has estimated insurance savings of roughly $20 per year for a car equipped with automatic belts. Over the lifetime of the car, this translates into a present value of $150 (33). A Highway Loss Data Institute study found reductions in Medpay and PIP claims of from 20 to 27 percent when comparing VW Rabbits with and without passive belts (13). These market data support the accident data findings that passive restraints are an effective means of reducing death and disability.

*Once again, it is important to keep in mind potential differences by car size, etc. However, the VW data suggest an incremental belt usage of 44 percentage points (78 percent of automatic belt owners not disconnecting their belts minus 34 percent of manual belt owners wearing their belts). The national disconnect rate under a mandatory system would have to exceed 45 percent, given manual belt usage in the vicinity of 11 percent, for incremental belt usage to fall below that of the Rabbit (55 − 11 = 44). Some participants in the passive restraint debate believe that such a disconnect rate would be exceeded.

COSTS OF PASSIVE RESTRAINTS

Estimates of the costs of passive restraint systems are abundantly available, but determination of the likely true costs remains a challenge. Most of the estimates come from the automobile companies, and according to one nonindustry analyst, these companies (33):

> . . . have a very strong incentive to engage in strategic estimates of costs. If the estimated costs are high enough, they may well persuade [NHTSA] to rescind the rule [FMVSS 208].

For some observers, both leaked company documents and analytical work have raised questions about the validity of manufacturers' estimates.

During hearings leading to the 1-year delay in implementing FMVSS 208, Ford and GM provided estimates of incremental automatic belt cost which averaged $114, including $88 for manufacturers' cost, $20 for markup, and $6 for incremental fuel costs (additional fuel consumed as a result of installation of the technology). Nordhaus (33) has argued that these estimates are inconsistent with the companies' estimates of their investment programs. He believes that a reasonable estimate for the true incremental cost to the consumer would be $60, instead of the $88 cited by GM. Nordhaus' figure is not inconsistent with earlier NHTSA and GM estimates based on incremental costs in Rabbits and Chevettes, which run (in 1981 dollars) from $42 to $85. GM points out, however, that automatic belt systems for large cars would be more expensive than those designed for small cars.* In terms of annual costs (i.e., amortizing and depreciating over the life of the car), the small-car range becomes $8.25 to $15.45 (3) (figures updated to 1981 dollars).

The costs of air bags are still less clear.** At one point, GM claimed that it would sell air bags for an incremental cost of from $290 to $325, assuming mass production. More recently, the company estimated large-volume consumer costs in excess of $600 per car. Ford's estimates have also varied. In 1976, Ford estimated a consumer cost of close to $400, but a recently leaked internal memorandum placed the figure at from $425 to $1,150. The same source indicated that for both Ford and GM, manufacturer cost would run only $135 to $140 (2). Other cost estimates by manufacturers range from $150 to $280. DOT developed an estimate of $190 (13,28).

Put together, these figures suggest that incremental consumer cost for the basic air bag systems probably would run from $250 to $425. Annual costs would range from $55 to $115. In addition, for those air bags deployed in vehicles which were not demolished, costs of reinstallation would become relevant. Such costs would certainly exceed initial installation costs under conditions in which air bags would be mass-produced standard equipment. However, such costs would apply to a very minor proportion of vehicles, since only a small percentage of air bags would ever deploy during the lives of the vehicles.

The variation in air bag cost estimates may represent some strategic gaming, as Nordhaus (33) suggests, but it also reflects several technical changes and uncertainties. Of fundamental importance is the question of scale. Several analyses emphasize the great economies to be realized from large-scale production. Ford estimated a 200-percent difference in per-unit manufacturer cost between producing a total volume of 885,000 cars and a volume of only 200,000 cars (2). In 1980, GM estimated a consumer cost of $1,100 based on a volume of 100,000 units, falling to between $650 and $700 if 400,000 units were produced.*

A separate estimate, based on quotations of components, found that the cost of a driver bag and inflator module would be 25 percent of its base cost (which assumed 13,000 units) if 900,000 units were purchased (28). Similarly, a passenger bag and inflator module would fall to 33 percent of base cost at the high volume. Some components, such as sensors and diagnostic parts, are not so sensitive to the scale, but the fact remains that the cost of an air bag system would be very dependent on the number produced and sold (28).

*D. Martin, General Motors, personal communication, 1982.

*Personal communication, 1982. Manufacturers' estimates in 1978 (updated to 1981 dollars) ranged from $84 to $140, depending on comfort and convenience features (28).

**All of the dollar figures in the remainder of this section are updated from their original sources to 1981 prices.

The costs discussed above are direct costs attributable to manufacture and installation of the passive restraint systems, plus small items of indirect cost (e.g., additional fuel consumption). Ignored in these numbers is the potential direct monetary benefit the owner of a passive-restraint-equipped vehicle might derive from lower insurance premiums. As noted above, the present discounted value of this benefit over the life of a typical car will total is $150 (33), a considerable offset to the incremental cost incurred by the consumer. Indeed, in the case of the automatic belt, the insurance savings outweigh the incremental price of the belt, implying that the purchaser of a passive-belt-equipped car could end up *saving* at least $35 over the life of the car (33).

5.
Cost-Benefit Analyses of Passive Restraints

5. Cost-Benefit Analyses of Passive Restraints

Should passive restraints be required on all new cars in the United States? Theoretically, the answer can be determined by a comprehensive cost-benefit analysis (CBA), one which accounts for all of the social costs and benefits associated with implementation of the rule—pecuniary and nonpecuniary, tangible and intangible. In practice, however, few CBAs even approach such a complete analysis.

Nonquantifiable costs and benefits and those which are quantifiable but not readily valued are commonly mentioned and then put aside; often they are ignored altogether. In either case, they are left out of the final calculus of the CBA which arrives at a "bottom line," an economic assessment of the worthiness of the program in question. As such, the "bottom line" is deficient. It can and should be recognized as a useful input into an overall assessment of the program, but it should not be viewed as the sole determinant of the program's desirability (20,50). This caveat should be kept in mind when reading this chapter.

CBA is in its ascendancy as a tool of policy analysis, particularly with regard to the issue of governmental regulation. Thus, it is not surprising to see that new CBAs entered the debate over Federal Motor Vehicle Safety Standard (FMVSS) 208 prior to the October 1981 rescission. What may seem more surprising, however, is that CBAs pertaining to the restraint issue date back more than a decade.

In 1970, Lave and Weber (20) examined the costs and benefits of seatbelts from the perspective of the individual and found that benefits exceeded costs if the value of an individual's life was at least $10,000, a number more than a full order of magnitude below the smallest estimates of the value of life (or livelihood) (50).

Lave and Weber failed to explain why, with benefits so much larger than costs, the majority of occupants choose not to wear belts. Thaler and Rosen (46) addressed this question in an analysis in which they compared the time costs of buckling up with the expected benefit. Thaler and Rosen estimated an annual benefit from wearing lap belts of approximately $10 (using a value of life of $200,000), and they argued that the individual's opportunity cost of time involved in buckling and unbuckling the seatbelt could easily exceed this amount.

Recently, Arnould and Grabowski (3) reexamined Thaler and Rosen's analysis (46) and undertook two CBAs: 1) the lap/shoulder belt from the perspective of the individual, and 2) from the point of view of society as a whole on passive restraint systems.

In the former, Arnould and Grabowski work with three different weighting schemes to value individuals' willingness to pay to avoid injuries of varying severity. They conclude that the expected annual benefits from regular belt use, $38 to $78 (in 1975 dollars), must exceed the time opportunity costs associated with buckling up.

Subject to two qualifications which they dismiss as insufficient to reverse their conclusion, Arnould and Grabowski argue that belt nonuse is not the result of rational, informed decisionmaking, as Thaler and Rosen had suggested it might be. To the contrary, these authors interpret their findings as supporting the "insensitivity-to-low-probabilities" hypothesis, discussed in chapter 2. It was found, however, that Arnould and Grabowski dismiss too readily the possibility that people value the freedom from discomfort (physical or psychological) produced by belts at more than the expected benefits. Over hundreds of hours of driving per year, the hourly discomfort cost would have to be extraordinarily low to dismiss this factor.

Arnould and Grabowski's passive restraint analysis is a competent, if standard, CBA of the social desirability of a system of mandated passive

restraints, either automatic belts or air bags. The analysis finds that both systems would produce substantial social benefits, with the benefits of air bags slightly exceeding those of automatic belts. However, the costs of the bags are so much higher than those of the belts that Arnould and Grabowski conclude belts are superior on the basis of net benefit (or benefit-cost ratio). Indeed, they find that only under very favorable conditions will air bags result in positive net benefits--i.e., the costs of bags quite likely would exceed the benefits.

Arnould and Grabowski's study is noteworthy for its sensitivity analysis, which tests the impact of varying assumptions on the benefit-cost conclusions. The analysis is thorough in its consideration of economic costs and benefits, but it merely mentions the costs of inconvenience and discomfort associated with belts—costs which must be considered potentially large, given all of the evidence on belt use. And, like almost all CBAs, the analysis ignores the costs of the suffering experienced by the loved ones of automobile accident victims. (This is discussed further below.)

Subject to these limitations, Arnould and Grabowski's analysis estimates that in a steady-state situation, i.e., after passive restraints were in virtually all automobiles (commonly estimated to require about 10 years), net benefits of passive belts could be as high as $8.5 billion and would not be likely to be less than $3.4 billion. Net benefits of air bags, by contrast, could reach $6.6 billion but could also be as low as −$4.9 billion. The analysis also calculates expected annual costs per life saved, which range from $135,000 to $557,000 for belts and $472,000 to $2,159,000 for bags.* Obviously, these cost figures attribute no value to injuries avoided. Lave (19) concurs with the finding that passive belts would be more cost effective than air bags, though he does not demonstrate analytically the basis of his conclusion.

Another recent CBA, by Nordhaus (32,33), was undertaken precisely to feed into the Department of Transportation's (DOT's) reconsideration of FMVSS 208. Sponsored by five major automobile insurance companies, this analysis also examined and compared the two passive restraint systems, although it was focused on passive belts, the system generally expected to dominate if FMVSS 208 had gone into effect.

The analytical slant taken in Nordhaus' CBA is somewhat different from that in Arnould and Grabowski's. Nordhaus concentrates on the (net) cost of delaying or reordering implementation of FMVSS 208, rather than making an "either-or" comparison of the status quo or a fully implemented passive restraint rule. As one of DOT's options was to rescind FMVSS 208 altogether, Nordhaus' analysis of the net cost of this option is directly comparable to other analyses of the net benefit of fully implementing a passive restraint rule.

Nordhaus estimates that, in a steady state, the annual net cost of a rescission would equal $2.4 billion, assuming that all cars are equipped with automatic belt systems. This number was derived from National Highway Traffic Safety Administration (NHTSA) and manufacturer data which Nordhaus believes to be in error, biased against the belt system; so he views his estimate as a lower bound on the net benefits of passive belts. Under these conservative assumptions, the benefits of the passive belt system ($3.6 billion) are three times greater than the costs ($1.2 billion). Nordhaus estimates the total discounted net social benefits of the passive restraint rule at $33 billion. Alternatively, $33 billion represents the net cost to society of a complete rescission of the rule. Under the assumptions that he believes to be more reasonable, this figure rises to $69 billion. Nordhaus summarizes his findings as follows:

> [T]he passive restraint rule is, from an economic point of view, as important as any environmental, health, or safety rule on the books. If the estimates of the impact on fatalities are accurate, a rescission would be equivalent to repealing a law that cuts in half the homicide rate. It is equivalent to forgoing the medical advances that allowed the virtual elimination of death from tuberculosis over the last quarter century.

Nordhaus' CBA shares with Arnould and Grabowski's an effective use of sensitivity analysis. Unlike Arnould and Grabowski, Nordhaus finds that a world of air bags would be preferable to a world of automatic belts. Despite the high cost estimate he uses to evaluate bags ($425), Nord-

*All of these figures are Arnould and Grabowski's estimates (3) inflated to 1981 dollars.

haus concludes that an all-bag system would generate total discounted net social benefits of $47 billion.* He does not dwell on the comparison, however, since at the time of his study belts appeared to be the wave of a 208 future.

As part of his policy analysis, Nordhaus examines the impact on the automobile manufacturers of implementing FMVSS 208. The only major organized opposition to implementation of the rule through the years, the manufacturers have expressed concern about the costs of adding passive restraints as standard equipment and what this would do to the demand for their product. The potential problem is of particular concern in 1982, with the domestic industry in a depressed condition. Nordhaus presents a case that adverse effects would be minimal. He suggests that it is even conceivable that the industry would benefit from implementation of FMVSS 208. This would occur if consumers recognized the net economic savings involved in buying a passive-restraint-equipped car, given an associated reduction in automobile insurance costs.

Nordhaus' is not the first CBA undertaken directly in connection with governmental evaluation of a passive restraint rule. In 1974, NHTSA released a CBA that demonstrated "the superiority of passive restraint systems compared to belt systems presently required" (13). The analysis was revised in response to criticisms and still came up with the same conclusion (13). Two years later, another CBA accompanied the announcement of a public hearing to be held by DOT.

At about the same time, Robertson (39) directed a survey which, though not itself a CBA, produced a finding of direct relevance to CBA: a sample of new car buyers expressed a willingness to pay an average of $12 more per month ($144 per year) in car payments to save 6,000 lives per year and $17 per month ($204 per year) to save 12,000 lives.** It appears that many new car buyers might stand prepared to pay considerably more than the amount passive belt systems would require. Whether answers to a hypothetical question would translate into equivalent action in the marketplace remains to be seen.

Graham, Henrion, and Morgan (9) have identified half a dozen other CBAs on the occupant restraint issue and have produced a detailed analysis of their own, one which compares passive restraint systems with other methods of encouraging restraint. Their analysis ranks FMVSS 208 below other alternatives in terms of both net benefits and benefit-cost ratio, with a compulsory belt usage law having the highest ratio (in large part because its measurable costs are so low) and a combined air-bag/mandatory-belt usage law producing the greatest net benefits (and saving the most lives). All of the alternatives these authors examine produce positive net benefits—i.e., each alternative is preferable to the complete absence of occupant restraints (and superior to the current system of merely requiring belts in cars). In particular, they estimate that the benefits of FMVSS 208 would have exceeded the costs by 95 percent.

Thus, CBAs have served as inputs, the importance of which is difficult to assess, throughout the long debate on a Federal passive restraint rule. Each of the analyses differs from the others in certain important ways: some adopt a human capital approach to valuing life (or livelihood), while others use willingness-to-pay (50); basic data sources, and hence magnitudes, often vary significantly; restraint alternatives studied differ from one analysis to the next; some analyses incorporate concerns like the effect of restraint systems on insurance costs, while others ignore them, and so on.

Almost all of the studies can be faulted for their failure to treat analytically the inconvenience and discomfort costs which, though nonpecuniary, seem to play a significant role in many people's decisions about using manual belts. It may be difficult or unreasonable to place a dollar value on such costs directly. However, there are sensitivity analysis techniques that would permit an evaluation of the potential significance of these costs. For example, one might employ break-even analysis to determine how highly people would have to value the inconvenience and discomfort in

*Recall that under the assumption he finds more realistic, Nordhaus found a greater net benefit for the belts. However, he does not apply a set of "more realistic" assumptions in the air bag case, relying instead on manufacturers' estimates of cost. Thus, this $47 billion figure should be compared with the $33 billion estimate for the belts.

**The dollar figures have not been adjusted for inflation, so they understate current value.

order to make passive belts appear to be socially undesirable (50).

Despite their idiosyncracies and their individual and collective flaws, as a body the passive restraint CBAs present an impressive case that society would benefit more than it would lose from a compulsory passive restraint rule. The findings are reasonably consistent and robust. In general, the studies rank air bags ahead of passive belts as life-saving devices, in large part reflecting the ability (and desire) of many passive-belt vehicle owners to disconnect their belts. With some notable exceptions, the analyses rank belts higher than bags on cost-effectiveness and cost-benefit grounds, primarily reflecting the much lower cost of the passive belt option. While all of the studies find passive belts to produce positive net benefits, several note that the positive net benefit of air bags is sensitive to assumptions.

Despite the uniformity of these studies' findings, the analyses have articulate critics who challenge basic assumptions of the models. In particular, while industry critics argue that belt cost estimates in the analyses are too low, most of the criticism is focused on estimates of passive seatbelt use. The automobile industry seems convinced that incremental belt-usage rates would be extremely low, assuming passive belts that could be easily disconnected (a condition that they believe would be demanded by the public). Thus, the industry views passive belts as increasing vehicle costs without significantly increasing effective passenger restraint. Current (manual) belt users would thereby be "punished" by an unnecessary additional charge, while confirmed nonusers would have to bear the same additional burden but would realize no additional protection (23).

In closing this glimpse at occupant restraint CBAs, several caveats should be mentioned. The first, illustrated by the work of Graham, Henrion, and Morgan (9), is that a finding that a mandatory passive restraint rule would be cost-beneficial does not necessarily mean that it would be the *most* cost-beneficial approach to saving lives through occupant restraint. Other alternatives should be compared in order to seek the approach that would maximize net social benefits.

Use of the phrase "net social benefits" suggests an important aspect, and limitation, of using CBA in a policy framework: as was noted at the outset of this discussion, reasonable costs and benefits are not the only, nor necessarily the most important, variables in policy decisionmaking. Above, studies were faulted for their failure to value discomfort and inconvenience; but other unmeasured variables may be of much greater consequence. For example, CBAs generally do not adequately address the issue of *who* benefits and *who* loses—not everyone realizes a net gain from implementation of a passive restraint rule—and it is this distinction that has made a (slow) horse race out of what appears to be a socially desirable objective (22). The distributional issue—winners and losers—constitutes one of the themes of the next and concluding chapters.

Finally, it should be noted that none of the CBAs attempts to directly value avoidance of the pain and suffering of accident victims and their loved ones.* As a result, the CBAs' findings of positive net economic benefit support the noneconomic desire to minimize human suffering.

*This is considered indirectly in willingness-to-pay valuations, though these generally cover only the victims themselves and not the suffering of people close to them. Furthermore, willingness-to-pay estimates suffer from people's inability to fully comprehend and contemplate their own deaths or serious disabilities (50).

6.
Philosophical and Ethical Issues in the Passive Restraint Debate

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Historically, the principal argument against Federal Motor Vehicle Safety Standard 208 has had a common two-pronged antiregulation structure: 1) mandating passive restraints represents one more example of governmental intrusion into individuals' rights to make their own decisions and run their own lives; it is a flagrant example of paternalism; and 2) mandatory passive restraints will increase the cost of car ownership,* unnecessarily raising expenses for people who currently use their manual belts and people who prefer not to be restrained (many of whom might disconnect automatic belts).

The "individual freedom" argument is not without merit, nor is it without very close precedent. The debate over delay or rescission of the passive restraint rule echoed the debate which has been repeated in recent years in one State capitol to the next as a majority of States have repealed their motorcycle helmet laws (51). Nevertheless, several factors mitigate the force of the freedom theme. These include economic and equity considerations, public opinion, and precedent.

Regarding the last of these, there are numerous precedents for Government's mandating auto safety features. Some involve driving behavior, such as speed limits and drunk-driving laws; and many, like the passive restraint rule, involve physical attributes of cars themselves—to name a few, shatterproof glass, energy-absorbing steering-wheel columns, padded dashboards, and today's manual lap/shoulder belts. Precedent does not make the next related case—i.e., passive restraints—necessarily "right," but it does serve as a supporting argument.

Public opinion is another consideration—in a democracy, ultimately perhaps the most important one. While survey results concerning passive restraints have varied, it is decidedly not the case that the public opposes passive restraints. For example, a 1977 Gallup poll found that of the 83 percent of respondents who had an opinion, a majority favored installation of air bags on all cars. This theoretical support for air bags does not disappear when respondents are reminded that they will have to pay extra to have this extra protection (13).* The will of the majority should not invariably dominate the rights of the minority, but in this case, given the limited input of public opinion into the decision, at least there is no question of the tyranny of the majority.

Conceptually, the most compelling responses to the "individual freedom" view have a theoretical base grounded in economic theory. Perhaps the most important of these are the negative externalities associated with the absence of adequate occupant restraint. Loosely, negative externalities are negative consequences visited upon one or more persons as a result of some other person's independent decisions or actions. In the occupant restraint case, negative externalities are of two types: economic and noneconomic.

Concerning the former, the nature of automobile and health insurance is such that the insured costs of automobile accidents are spread over large numbers of car and health insurance policyholders (and taxpayers in the instance of public health insurance). Thus, if an unrestrained victim of an automobile accident experiences greater injury and hence higher medical bills than would have been the case had he or she been restrained, others share in the economic liability created by the medical treatment. In effect, one person's independent decision not to wear a seatbelt has ad-

*As was noted in the preceding chapter, if insurance rates for passive-restraint-equipped cars fall, the *net* cost of owning a car with an automatic belt might decrease, even though the showroom sticker price would rise.

*Once again, the question is whether (or how much of) such survey support would translate into market decisions. The automobile manufacturers seem convinced that in practice consumers will not be willing to pay the high cost air bags would entail (23). It should be noted, however, that the industry's limited experience in this regard involves a radically different set of circumstances than would obtain in a world of mandated air bags.

verse consequences for other people's pocketbooks. Pecuniary negative externalities such as this constitute a technical market failure and serve as a theoretical rationale for governmental intervention.*

The noneconomic negative externalities concern the health risks imposed on people other than the initial car buyer, and refer specifically to air bags, not passive belts. If the initial buyer purchases a car equipped with an air bag, all future frontseat occupants—passengers, children, second and third owners—will receive that protection. If the initial buyer does not purchase an air-bag-equipped vehicle, future passengers will be subjected to greater risk. This argument depends further on some specific economic conditions, which will be returned to, but it is sobering to note the following statistics from a study of 137 crashes (with 172 people injured) in Baltimore County, Md. (4):

- approximately half of the people injured were occupants of vehicles no longer owned by their original purchasers;
- nearly 60 percent did not own the vehicles in which they were injured;
- three-quarters of the passengers were not related to the vehicle owners; and
- almost two-thirds of the victims were under the age of 30, and only one-third of 16- to 29-year-olds injured owned the vehicles in which they were injured.

In effect, these data challenge, or at least question, the argument that new-car purchasers should be free to determine whether to invest in safety devices like air bags since it is their own protection that is in question. The health and safety of many others are also involved. In a well-functioning market, one might find this potential externality acceptable. After all, people can and should choose not to ride in cars in which they do not feel adequately protected. And, more to the point, future owners of used cars can have desired safety equipment added when they purchase their cars. But can they, in the case of air bags?

There may be firms that will retrofit a car to have air bag protection, but the cost is quite high because of the small scale of the business and the sizable economies of scale that pertain to air bag manufacture and installation. Thus, the prospective buyer of an air bag system is penalized economically by the small scale of active demand for air bags. Alternatively, all of those people who would want to purchase air bags at mass-produced prices would benefit from a requirement (or industry decision) to install bags in much of the new-car fleet.*

Clearly, there is one obvious group of potential economic victims of a passive restraint law: current regular users of manual lap/shoulder belts. They are already receiving all of the protection that would be afforded them under a mandatory passive restraint rule, yet under such a rule they would have to pay more for their new cars. In effect, they would be penalized for other drivers' poor judgment. If Nordhaus' (33) assessment is correct, the net cost of automobile ownership would drop under a passive restraint rule, benefiting current belt users as well as nonusers. But one might argue that current users should *already* be receiving an insurance break, something insurers do not offer—in large part presumably because of the problem of verification of belt use (see ch. 3).

Thus, the "individual freedom" argument has pluses and minuses. Certainly there is a public interest in passive restraints which competes with the private interest in free individual choice; this is not clearly a case of unwarranted governmental intrusion, pure and simple. Which of the interests one rates as dominant probably reflects one's basic political philosophy as much as the inherent merits of the case.** In this regard, it is

*Some of these pecuniary externalties could be overcome through the market. For example, insurers could charge lower (actuarially fair) personal injury protection (PIP) and medical (Medpay) premiums for owners of passive-restraint-equipped vehicles, as a couple of insurers are currently doing. However, other pecuniary negative externalties could not be addressed by the market. Consider, for example, the accident-related medical costs of Medicare and Medicaid beneficiaries.

*A ready response to this problem is that people can use the already required lap/shoulder belts and receive nearly the same amount of protection. However, the above argument applies to the apparently sizable segment of the population that chooses not to wear belts, perhaps for reasons of discomfort, but would like to purchase air-bag protection at a reasonable cost, though not at current small-scale high market prices.

**For a recent debate on this theme, see Perkins (36) and Baker and Teret (5).

interesting to read the assessment of George Will (52), noted conservative political analyst, commenting on the view "that Government has no business requiring drivers to buy and use inexpensive devices that might save them from self-destruction:"

> There is a pitiless abstractness, and disrespect for life, in such dogmatic respect for the right of consenting adults to behave in ways disastrous to themselves. Besides, too many children passengers are sacrificed on that altar. And a large part of the bill for the irrationality of individual drivers is paid by society.

7.
Conclusion

7. Conclusion

There *is* a basic philosophical issue in the debate on passive restraints—one which has risen to prominence in an antigovernment, antiregulation era. Nevertheless, it is important to recognize that the principal deterrent to implementation of a passive restraint rule has been opposition on the part of automobile manufacturers—grounded, it appears, in concern about the economic implications of passive restraints for the industry, and not the issue of individual freedom.* Nordhaus (33) has concluded that the ramifications probably would not be as dire as industry statements and documents seem to suggest, at least with regard to the demand for automobiles and manufacturer and dealer revenues. However, there is a long history of manufacturer opposition, with repeated proposals for the voluntary phasing in of passive restraints generally going unrealized (13,17).

The impact of higher car prices on the demand for automobiles—the issue addressed by Nordhaus—is only one of the manufacturers' concerns. Manufacturers have also expressed concern over the effect of passive restraints on product liability claims, worrying "that 'endless lawsuits' would allege the failure of automatic restraints to provide adequate protection" (28). Furthermore, given a climate of "exaggerated public expectations" about the effectiveness of passive restraints, they have anticipated lawsuits as a result of an occupant injury even when restraints worked as they were supposed to. Thus, the availability and cost of liability insurance, manufacturers have feared, could loom as serious problems.

But some evidence suggests just the opposite. For a variety of reasons, insurance might be abundantly available. And there is reason to believe that passive restraints might decrease, rather than increase, the number and size of liability claims. For one thing, automatic restraints should decrease the number of deaths and serious injuries resulting from crashes attributable to manufacturing defects and design problems such as stalling engines, malfunctioning brakes, and tire blowouts (28).

In considering the support for and opposition to mandatory passive restraints, one should recognize that most of the organized interests fall into the support camp. Insurers have expressed their support frequently and strongly. The American Mutual Insurance Alliance, a group representing over 95 percent of all of the automobile insurance written in the United States, has gone on record as unequivocally favoring mandatory passive restraints (13). And, as discussed above, a few major insurance companies have already put their corporate mouths where their money is, offering premium reductions to owners of passive-restraint-equipped vehicles.

There is an irony, however, in the likely outcome of implementation of a passive restraint rule: a major but unorganized interest group, automobile consumers, has expressed an apparent preference for air bags over passive belts; yet the National Highway Traffic Safety Administration (NHTSA) has estimated that if passive restraints were required, 99 percent of the new-car fleet

*This point is made quite clearly in General Motors' (GM's submission to the Department of Transportation for the 1981 hearings on passive restraint options (23):

> We believe that [this issue of mandatory passive restraints] . . . hinges squarely on what the American public is willing to accept in terms of economic or behavioral burden. Inflatable restraints are too costly to be acceptable to most . . . automatic belts that are coercive will be rejected by the public. Noncoercive (separate) automatic belts will not significantly increase belt use over that achievable with manual belts, and thus will not be cost effective.
>
> Because we believe that the rule will not work, we recommend that it be rescinded . . .
>
> Should the Government determine that additional regulation is necessary, a mandatory belt use law will be more effective, sooner, and at a fraction of the cost of a passive restraint rule.

The mandatory belt use law clearly violates the individual freedom perspective at least as much as would passive restraints. Thus, GM's concerns seem firmly grounded in pragmatic economic considerations.

On that pragmatic level, GM's points are worthy of serious attention. GM is arguing, in essence, that the CBAs overestimate the amount of incremental belt usage that would be achieved under a passive restraint rule, and that the low levels GM anticipates would flip the cost-effectiveness balance over. In this regard, note that Arnould and Grabowski (3) found that an incremental belt usage rate of only about 20 percentage points is all that would be needed to make passive belts cost effective. Of course, while they might be *cost* effective at that level, their effectiveness would be small compared with the injury problem and the potential of belts to reduce it.

would have passive belts, with only 1 percent of cars coming equipped with air bags. The manufacturers must have concluded that whatever consumers' abstract preferences might be, in buying practice most consumers would not choose to pay the extra cost required for air bags (23).

There is further irony here, one that has a distinct *Catch-22* flavor: air bags are clearly effective in significantly reducing motor vehicle injuries and fatalities—yet because the automakers are convinced that consumers would not be willing to pay the high cost for the air bags, they planned to produce primarily passive belts had Federal Motor Vehicle Safety Standard (FMVSS) 208 remained in effect; yet because they believed that most passive belts would be disconnected, they argued forcefully, and successfully, that passive belts were not cost effective, and hence that FMVSS 208 should be rescinded.

Mandatory passive restraints would have represented only one addition to a lengthy list of technological safety features required on automobiles by the Federal Government. But passive restraints are of special interest and importance for two reasons: 1) because of the long delays and often acrimonious debate over implementation of FMVSS 208, and now over its rescission; and 2) due to the realistic potential of these technologies to make an extraordinary dent in the death toll of automobile accidents. Estimates vary, but the consensus suggests that passive restraints could prevent a minimum of 6,000 and perhaps as many as 12,000 highway deaths a year. Given the current total of roughly 27,000 frontseat occupant deaths a year, a savings of this magnitude would constitute a truly major public health victory.

Less dramatic than lives saved, but more numerous, would be injuries avoided. Here the estimates also vary widely, depending in large part on the severity of the injuries considered. Arnould and Grabowski (3) estimate that from 20,000 to 40,000 severe injuries (Abbreviated Injury Scale 3 to 5) would be prevented by passive restraints each year; Nordhaus (33) estimates that 120,000 moderate to critical injuries would be avoided. However they are grouped and counted, injury reductions would be impressive.

With the demise of the passive restraint rule, and over a decade of working toward its realization, NHTSA has a special obligation to seek alternative strategies to reduce the motor vehicle accident toll. The chore remains the same as before—to find a cost-effective, politically acceptable means of providing effective vehicle occupant restraint. The air bag represents a technology that is effective and that would apparently be acceptable to the public, were it not for its great cost. At the other extreme lies the mandatory belt-use law—an approach that might be quite effective and inexpensive, yet appears to be politically unacceptable. In between lies a myriad of alternatives that are probably more acceptable and less effective (e.g., a renewed public information campaign). Recent analyses suggest that a mix of approaches should be explored.

From the point of view of OTA's study *Technology and Handicapped People*, it is unfortunate that automobile accident data do not permit a careful assessment of the number and severity of handicaps resulting from automobile accidents. Data on disabilities resulting from accidents are not particularly good, and disabilities do not invariably become permanent (or longstanding) handicaps. Nevertheless, despite these data deficiencies, simply considering the number and nature of serious motor vehicle accident injuries suggests the truly extraordinary potential of occupant restraints to reduce disabilities and handicaps.

In the context of a case study of the technological prevention of handicaps, the importance of this reduction is twofold. From a social/fiscal point of view, the resource savings attributable to this prevention technology appear to be substantial. The costs of technologies for handicapped people, both individual and collective, are considerable, as a glimpse at the main OTA report immediately suggests. The prevention of handicaps requiring use of these technologies implies a savings of economic resources by reducing the need for the technologies.* Thus, any policy

*This is a benefit of the prevention of technology that should be included in a cost-benefit analysis (CBA). The CBAs on passive restraints consider many such resource savings—e.g., medical expenses avoided—but undoubtedly miss the reduction in the need for many of the collective technologies for the handicapped. To this extent, the passive restraint CBAs understate the net benefits of mandating passive restraints.

deliberations on resource allocation to address the problems of the handicapped should give serious consideration to prevention efforts as viable means of reducing the total societal costs of handicaps.

More to the point, the *true* costs of handicaps vastly exceed those that can be readily measured in dollars and cents. The physical and psychological suffering that accompany handicaps are costs for which no technology can ever fully compensate. But some technologies, like motor vehicle passenger restraints, can prevent this suffering. The full value of this benefit, included in none of the passive restraint CBAs, must be enormous (1). Thus, regardless of its purely fiscal implications, the prevention approach warrants especially careful attention.

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